

Seasonal Weight Changes in Raccoons (Carnivora: Procyonidae) of North Carolina

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ABSTRACT.— Raccoons, *Procyon lotor* L., were studied in North Carolina to determine if seasonal changes in body weight occur in this species in a mid-latitude region. The sample consisted of live-trapped animals and intact carcasses from a fur buyer. Juvenile male body weights increased from the end of July to mid-December 1975. Body weights of juvenile males and females tended to decline between mid-December 1975 and February 1976. During the midwinter of both 1975 and 1976, adult male and female body weights decreased; the decline was less extreme and occurred about two weeks later than declines reported for the northcentral United States. This pattern of weight loss at higher latitudes may reflect the greater energetic cost of raccoon winter foraging at northern locations. Such sites experience lower temperatures than more southerly sites, and their ground vegetation is less accessible because of deeper snows.

INTRODUCTION

Systematic seasonal changes in body weight occur in a variety of nonhibernating mammals (for examples see Keller and Krebs 1970; Markham and Whicker 1973; Iverson and Turner 1974; Mautz 1978). This is not surprising since food quality and/or quantity normally vary within a year. Except for those of Iverson and Turner (1974) and Mautz (1978), most reports of such seasonal weight changes are presented without ecological explanations, or as events associated with population cycles (e.g., Keller and Krebs 1970). In this study we examined raccoons, *Procyon lotor* L., in North Carolina to determine whether such changes occur in this species in a mid-latitude region. Seasonal body weight changes have been documented in raccoons from the northern (Stuewer 1943a; Mech et al. 1968) and southern (Johnson 1970) United States. Thus, we could also evaluate geographic variation in this phenomenon.

METHODS

This study was conducted in the North Carolina piedmont from January 1975 through February 1976. Study areas included the Ecologi-

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cal Research Area of North Carolina State University (NCSU), 3.2 km southwest of Raleigh, and woods in two nearby locations: Schenck Forest and the Faculty Club, both of NCSU.

Live traps baited with sardines and corn were placed along stream bottomlands and checked daily. Twenty-two captured raccoons were restrained in a wire cone (Stuewer 1943b), weighed (± 1.0 g), measured (± 0.5 mm), sexed (Stuewer 1943b), ear tagged, and released. Additional data were obtained from 123 intact carcasses from a fur buyer in Smithfield, 48.3 km south of Raleigh. All of these raccoons were trapped within a 150 km radius of Smithfield less than two weeks prior to examination (L. Barbour, pers. comm.). Exact capture dates were not known for about 75% of the specimens. As approximations used to compute regressions of body weight over time, dates for these animals were estimated to be seven days prior to the date of necropsy.

The dead raccoons were aged by degree of epiphyseal closure seen in X-rayed radii and ulnae (Sanderson 1961). We analyzed the data from the noncastrated raccoons in Sanderson's (1961:9) Illinois sample and found that the mean ages of females with broad, thin, and closed epiphyses were all significantly different ($P < 0.01$) with little overlap between the means' 95% confidence limits. Since these means corresponded nicely with year classes, we categorized our females with broad epiphyses as juveniles (\approx zero-one yr), with thin epiphyses as subadults (\approx one-two yr), and with closed epiphyses as adults (\approx two yr). In Sanderson's study, the only significant difference ($P < 0.01$) was between the mean ages of males with broad and thin epiphyses. Again, matching epiphyseal closure with mean age, our males were classified as juveniles (\approx zero-one yr) or adults (\approx one yr). Fifty raccoons, including those live-trapped, were not X-rayed. Instead, they were assigned to age classes by comparing their total lengths and body weights with the means and 95% confidence intervals of these variables displayed by the animals we did X-ray.

Weights of males and females were plotted separately against dates by age. We noted that weight typically increases during the fall or early winter through December, and is followed by a midwinter decrease. Weights of juvenile males increased by midsummer. Stepwise regression analyses were used to determine if these visually observed changes were statistically significant.

RESULTS AND DISCUSSION

Although adult weights decreased during January and February of 1975 and 1976, the only statistically significant change was for males in 1975 ($r = -0.45$; $P < 0.05$; $N = 20$). However, since the pattern was consistent in both sexes each year, it appeared real and justified data pool-

ing. Slopes and intercepts of the descending lines of adult male body weight in January and February were similar in 1975 and 1976 ($P > 0.05$, F-test); the same was true of adult female body weights. The negative slope of the pooled male sample was significant ($r = -0.45$; $P \cong 0.01$; $N = 30$) and the pooled female data also provided a clearly decreasing body weight trend ($r = -0.44$; $P \cong 0.08$; $N = 18$). These adult weight decreases in January and February were compared between sexes (F-test). Slopes were similar ($P > 0.05$) but intercepts were not ($P < 0.01$), with males being typically heavier.

In Minnesota, Mech et al. (1968) reported a 50% weight decline in adult raccoons from late November through mid-March followed by a weight gain beginning in mid-April. Adult raccoon weights were also found to be minimal in the spring in Michigan (Stuewer 1943a) and Alabama (Johnson 1970). In Alabama, however, spring weights were only about 20% less than those in the fall. We also found this midwinter weight decline to be less extreme in North Carolina. In the pooled sample regressions, expected values of adult weight decreased by 22% for males and 27% for females through January and February. Further, this winter decline in adult raccoon weights begins about two weeks later in North Carolina than it does in the northcentral states (see Stuewer 1943a; Mech et al. 1968).

Body weights of juvenile male raccoons increased from the end of July to mid-December 1975 ($r = 0.71$; $P < 0.05$; $N = 12$), followed by an insignificant decreasing trend through February 1976 ($r = -0.43$; $P > 0.05$; $N = 5$). Juvenile female weights also declined from mid-December 1975 through February 1976 ($r = -0.65$; $P \cong 0.06$; $N = 9$). Similarly, both Stuewer (1943a) and Mech et al. (1968) found that body weights of juvenile raccoons in Michigan and Minnesota increased until November of their first year and then declined. We also observed yearling female weights to increase from November 1975 through January 1976 ($r = 0.85$; $P \cong 0.08$; $N = 5$), another pattern consistent with those found farther north by these authors.

Iverson and Turner (1974) suggested that mammals lose weight when it is adaptive to lessen energy requirements in certain seasons. However, a weight decrease normally occurs by fat loss, which need not imply lower energy requirements. Energy demands could even be relatively high in fat depleted individuals. For example, raccoon weights are lowest by winter's end, a time when energy requirements for upcoming breeding events should be high.

We suggest a less complicated explanation, which is simply that animals put on weight while food is readily available to prepare them for the harsher winter and early spring. Mautz (1978) argued that white-tailed deer, *Odocoileus virginianus*, add fat in summer and fall to offset

the lower nutritive value of winter browse. Both situations are, of course, analogous to that occurring in many hibernators (e.g., Davis 1976). In raccoons, fat stores would become depleted in winter because of (1) higher metabolic costs of staying warm, (2) more energetically expensive foraging associated with greater reliance on predation (Johnson 1970), which is a more active type of foraging, and (3) reduced overall food intake because of sparser food sources. Northern latitudes, with colder temperatures and vegetation made less accessible by deeper snows, should be the most energetically demanding places for raccoons in the winter. This would explain the latitudinal differences in adult weight loss. Other comparisons support this explanation. The periods of yearling weight increase and adult weight decrease occur later in North Carolina than in the northcentral states and are less extreme. Where winter arrives later and is not as harsh, weight gains need not occur as early to ensure survival. Instead, energy stores that last longer into the winter should delay weight loss.

Winter foods of raccoons might be of low nutritive value. But, since raccoons are extremely omnivorous, this should be less a factor in their weight changes than for those in obligatory herbivores like deer (see Mautz 1978). Furthermore, since raccoons exhibit denning behavior and often forage at night, when winds are typically less severe, they might have lower winter energy demands per unit weight than deer. Certainly, other factors such as the insulative quality of the fur and physiological adaptations also need to be considered for a valid comparison to be made.

Finally, breeding activity in the later winter and early spring might influence the pattern of adult raccoon weight decrease by causing a further drain on fat stores. In a separate study (Zeveloff and Doerr 1981) we found a high negative correlation between mean body weights and mean testis weights of 16 adult male raccoons from mid-January through February 1976 ($r = -0.99$; $P < 0.01$). This indicates that male body weight decreases at a time of increased reproductive activity. To fully understand raccoon body weight dynamics, one might consider their reproductive events in addition to geographic variation in climatic seasonality and food availability.

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